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Andrei, Dalina Maria; Andrei, Liviu C.

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## Vector error correction model in explaining the association of some macroeconomic variables in Romania

Dalina Maria Andrei<sup>a</sup>, Liviu C. Andrei<sup>b\*</sup>

<sup>a</sup>*Institute of Economic Forecasting, Romanian Academy, 13,13 September str., Sector 5, 050711, Bucharest, Romania*

<sup>b</sup>*National School of Social, Political and Administrative Sciences (SNSPA), Povernei str. 6-8, Sector 1, Bucharest, Romania*

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### Abstract

The purpose of this article is to empirically analyze the long and short runs association of some macroeconomic variables in Romania. Variables used across regression include foreign direct investments (FDI), imports, exports, GDP and labour and we also take into account some economic and financial crisis' influence on these. In order to establish this influence, a dummy was used for the 2008-2012 interval. Then, all variables were found to be integrated of order one I (I). Cointegration was performed under Johansen test and a VECM was applied according to its result. Our model results point on the association between variables on both long and short runs. Then, Granger test under VECM was equally applied in order to establish the uni- or bi-directional causality between variables. We found that the economic crisis actually caused significant influence on FDI, imports, exports and GDP and rather no influence on labor, as reliable resource.

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**Keywords:** Foreign direct investments, Economic and financial crisis, Cointegration, VECM model;

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### 1. Main text

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

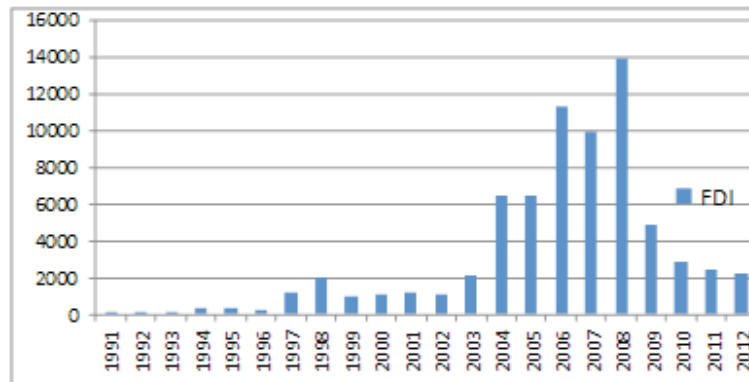
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\* Corresponding author. Tel.: +40.021.3188148; fax: +40-21.3188148.

E-mail address: [dalinaandrei@yahoo.com](mailto:dalinaandrei@yahoo.com)

Two significant periods are to discuss about for Romania, as regarding the FDI story. The first one includes nearly the whole 90ies decade. It was a period of what is today called insignificant FDI and investors; the other was the opposite and the year 2000 of it was conclusive, together with contemporary development. FDI was also more tightly connected to home investments. Top multinationals world-wide were finally present in Romania as well and Romania's FDI-related landscape radically changed (Andrei, 2008). Then, ten years later, in 2009 and next 2010 the FDI inflow changed once more, but this time in the negative way due to crisis, but maybe not only.

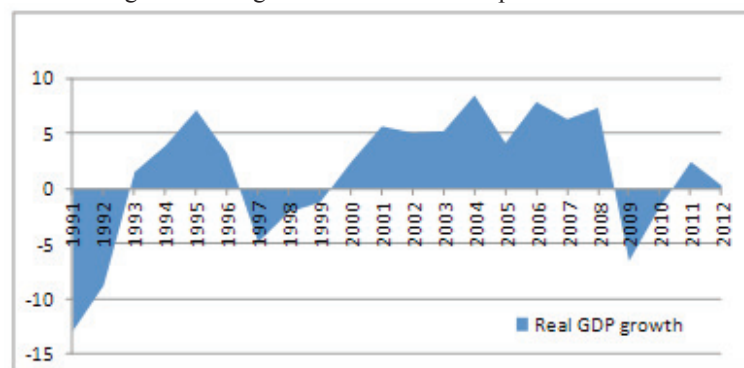
Back to the 2003-2010 interval, the Romania's FDI inflow met a relatively stable growth up to 2004, then speeded up on 2004-2007, as concomitantly with EU's important two waves extension. Actually, the country succeeded on multinationals' interest later one decade later than its neighbour countries. In 2004-2005 the country that had missed FDI ten years earlier was receiving the highest inflow in the region. It was a moment in which FDI inflow and economic growth were really going hand in hand for Romania (Andrei 2008). But there also was the moment of EU and especially Euro-zone member investor countries' domination in Romania. However, there was n individual investor country's domination in this case (Andrei 2002-2010). Then the 2010 decline of FDI (after having performed 2004, 2006 and 2008 peaks) was reducing the inflow by some 22%, as compared to the previous 2009. Then, FDI seem to meet a certain recovery in recent years 2011 and 2012, but the heights of before crisis are yet expected to come back.



Source: UNCTAD Statistics

Fig.1: FDI evolution 1991-2012

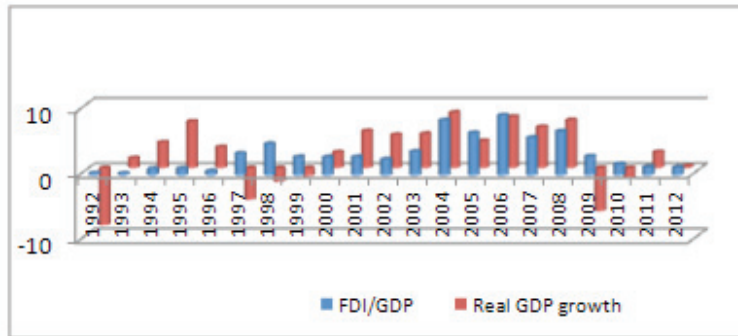
See nearly the same for GDP growth in Figure 2 about the end of period:



Source: UNCTAD Statistics

Fig. 2. Real GDP growth evolution 1991-2012

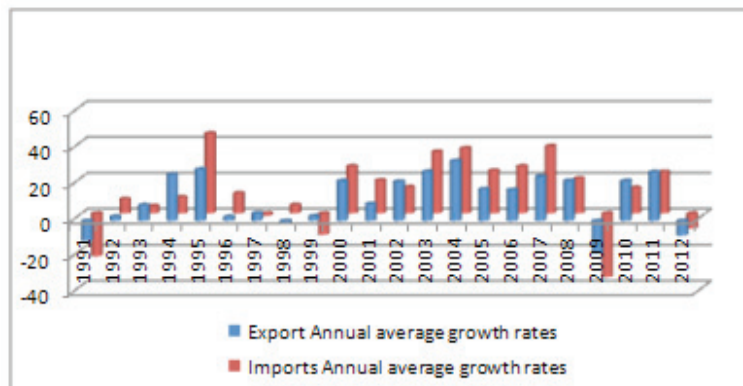
As a result for the same 1991- 2012 interval the FDI/GDP ratio that obviously varies:



Source: UNCTAD Statistics

Fig.3.: FDI/GDP and real GDP growth 1991-2012

And apart from the above imports and exports annual average growth rates in Figure 4:

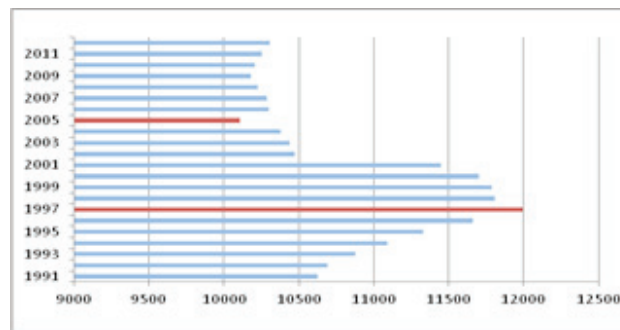


Source: UNCTAD Statistics

Fig. 4. Imports, exports on annual average growth rates 1991-2012

Also, in 2012 the EU **labor market** was still determined by the economic crisis. Key figures for the EU did not improve: they either continued to show negative trends (unemployment) or remained relatively stable in relation to the year before (employment). In addition, developments in the labor market did not affect Member States in the same way or to the same extent. As a result, the differences between Member States increased.

Labor force total in Romania was last measured 10.200 (thousand) in 2012, according to the World Bank. Total labor force comprises people ages 15 and older who meet the International Labor Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed or economically inactive.



Source: UNCTAD Statistics

Fig. 5. Evolution of total labor force (absolute value in thousands)

## 2. Literature review

Interaction between these variables is complex and each variable (GDP, exports, import, labour and FDI) has a plausible theoretical foundation to affect the other variables. Foreign capital flows **FDI** may affect the macroeconomic strength of the host countries. Most developing countries face the problem of insufficient capital within the country and hence need the inflow of foreign capital (Majeed and Ahmed, 2013). Many studies on FDI have explored its nexus with the exports; Klasra (2009), Majeed and Ahmed (2013), Athukorala and Menon (1996) explain the role of FDI in export expansion and employment generation, Samsu et al (2008) investigated the causal relationship between FDI inflows and exports in Malaysia. The literature on FDI, trade and economic growth generally suggests a positive relationship between those variables, Jayachandran and Seilan (2010).

**Imports** (annual average growth rates), consider the idea of Mundell (Ferris, 1993) after which FDI would be directly affected by them - more, restricting imports option affects investors' international expansion. Another time, "FDI substituting imports" was one of the few theories on the dynamics of these international capital transfers. Other theories consider, on the contrary, the so called "vertical integration" of international companies in the local area, leading to an inverse correlation imports FDI (Zhang & Markusen, 1999).

**Exports** (annual average growth rates), raises the degree of integration of the domestic market in international environment - domestic labor market can leave place for wage growth, and for other domestic costs of production, which diminish the incentive for foreign investors. For which we find already here rather negative relationship FDI exports. Alternative judgments see here an incentive for foreign investors, already obtained access of local companies in the international market, so a positive relationship with FDI, at least for a certain category of investors. Erdal (2002) had a third point of view, that both exports and imports increase the degree of international integration. Vernon (1966) believes that increasing the attractiveness of the domestic market is the result of strengthening economic relationships with international space, international standardization of the product and its globalization

**GDP** – as real GDP growth rates in our model keeps something of its general multiple significance: production capacities, home market dimension and purchasing power. As for FDI endogenous the FDI-GDP correlation, taken as positive, would so point on non-residents' higher option for a correspondingly higher absorption as such.

In our model, real GDP expressed as growth rates (average annual growth rates) Also, economists observed that the development and employment of human capital is important in a nation's economic growth. Human capital refers to the abilities and skills of human resources and human capital development refers to the process of acquiring and increasing the number of persons who have the skills, education and experience which are critical for the economic growth of the country (Harbison, 1962).

## 3. Data definitions and sources

This paper uses annual time series data for FDI (as a report of GDP), real GDP growth, Export (annual average growth rates), Imports (annual average growth rates) and labour force (annual growth). We also used a dummy

variable in order to capture the impact of economic crisis. The dummy variable will take value “1” in 2008-2012 intervals and “0” otherwise. All data are collected from UNCTAD statistics, 2014 that would also ensure relevance and substance of data.

#### 4. Augmented Dickey-Fuller test statistic for unit roots

Usually, most economic variables are non-stationary. It is therefore important for the research to test for stationarity before generalizing any relationship. So we are starting to test for the presence of unit roots using the Augmented Dickey-Fuller tests. Dickey (1976) and Fuller (1976). The test reveals that all the variables are non-stationary. They were made stationary after the first difference: Granger and Newbold (1974) noted that the regression results from the VECM models of the Granger causality tests using non-stationary variables will be spurious. To avoid this, we will run the regression with the stationary variables after differencing.

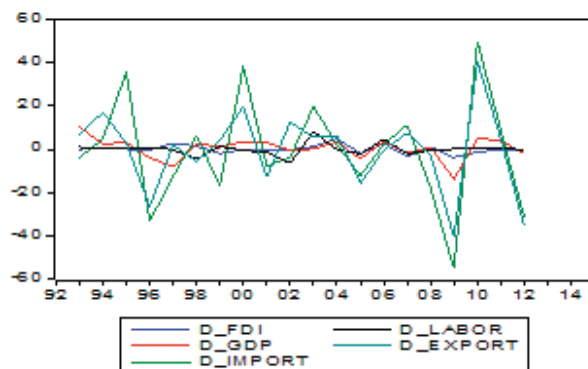


Fig. 6. Differenced and stationary data

We tested also the normal distribution of the differenced series, applying histogram and statistics. The result of the test proves that the series are normally distributed for 5% significance level.

#### 5. Results of Co-integration

If our variables are found to be cointegrated, that is there exists a linear, stable and long-run relationship among variables, such that the disequilibrium errors would tend to fluctuate around zero mean. In literature, Co-integration tests, e.g. Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990), Pesaran et al (2001) etc are used to confirm the presence of potential long run equilibrium relationship between two variables. We used Johansen's technique in order to establish how many cointegration equations exist between variables. The results show that the maximum eigenvalue statistic suggests the presence of one cointegrating equation among the four variables in the Romanian economy at 5% level. Our test suggests that our set of cointegrated time series have an error-correction representation, which reflects the long run adjustment mechanism.

#### 6. The Vector Error Correction Model (VECM)

If a set of variables are found to have one or more cointegrating vectors then a suitable estimation technique is a VECM (Vector Error Correction Model) which adjusts to both short run changes in variables and deviations from equilibrium. Lag length criteria also suggest the chosen of one lag for estimating VECM.

General form of VECM model used is:

$$\Delta Y_t = a_1 + a_2 \text{ec}_{t-1} + a_3 \Delta Y_{t-1} + a_4 \Delta X_{t-1} + \epsilon_t \quad (1)$$

A crucial parameter in the estimation of the VECM dynamic model is the coefficient of the error correction term,

( $\epsilon_t - 1$ ), which measures the speed of adjustment of economic growth to its equilibrium level. Thus, we expect a positive sign of dummy variable on evolution of FDI, GDP, TRADE and LABOR. In order to establish the joint effect of variables, under VECM all those variables are taken as endogenous ( $\Delta Y$ ) and exogenous ( $\Delta X$ ), in order to establish the long and short run association between them. We applied a VECM model with one cointegrating equations and under reviews environment we estimate with OLS, a system of five equations, ordered by each variable.

Short run effects are captured through individual coefficients of the differentiated terms. That is captures the impact while the coefficient of the VECM variable contains information about whether the past values of variables affect the current values of the variables under study. The size and statistical significance of the coefficient of the error correction term, measures the tendency of each variable to return to the equilibrium. A significant coefficient implies that past equilibrium errors play a role in determining the current outcomes captures the long-run impact.

## 7. Results and Interpretations

Two aspects are to be considered, as common for our modelling on FDI in this paper. Firstly, dummy here taken appears significant (under 5% null probability for coefficients) and shows the highest coefficient of each equation as the very rule, certainly meaning that crisis impedes on nearly all macroeconomics here considered. The whole exception to this rule identifies active labour resource in last equation 5 and it is partial – i.e. in this equation dummy coefficient is the highest, as in the other equations, but it is not significant as regarding the null probability of this coefficient that is much higher than 5%. Besides, this last equation is an exception for other points of view, as well, e.g. lowest R-Squared of this set of equations, but also see other exceptions below.

*FDI endogenous* appear keeping some long term causalities with their afferent exogenous (i.e. C1 coefficient). Besides, short run causalities significantly identify, in the decreasing order of corresponding coefficients-influences on: other factors, active labour and negatively on the precedent period FDI and imports. The precedent period FDI have the highest influence on current FDI, despite negative, of the list of considered FDI exogenous; it is followed by imports, as negative influence.

On the other hand, there are factors not included in this equation that keep positive influence on FDI, as higher than each considered variable, be it positive or negative. Active labour finally keeps another important positive impact on FDI.

Actually, our FDI appear, in a way, as import-substitution: old imports look to have been ‘moved into the country’, as shifting from abroad supply to home production, probably for home consumption, as well. Besides, home active labour, as available, remains a pretty good stimulus for FDI inflows, whereas these inflows rather adjust themselves in medium term.

*Exports endogenous* appear not with long term causalities face to their exogenous, as FDI do in previous case. And as for the short run influence, FDI keep a significant part which is negative again. It looks like FDI do trouble home exports, possibly on various ways: home traditional firms exporting, as in higher competition environment, foreign investors moving production into the country for stopping old imports from the country, predominance of foreign companies' production for the home market area, instead of exports etc.

*GDP endogenous* equally appears not with long term causalities face to its exogenous, and as for short run causalities only precedent period FDI appear significant (null probability of coefficient under 5%), plus good number but negative sign coefficient. FDI keep negative impact on GDP possibly when they engender home production restructuring, instead of positive stimulant, e.g. older home firms lowering output for less market demand, bankruptcies, rather small and medium size home enterprises not yet adapted as suppliers for the new big foreign companies etc.

*The import, as endogenous also does* not prove long term causalities with their exogenous either but there are also short term causalities proven by: precedent period FDI and precedent period GDP, both as negative influences, and exports, as positive influence. Imports in the country look embarrassed by both home GDP and FDI that substitute (i.e. replace) the home specific needs and dependence from the international market. As concomitantly, exports' common sign with imports' evolving prove the production link between – there predominate substitution (production) imports against imports for consumption.

*Active labour endogenous* does not proves long term causalities with its exogenous considered. But its specific



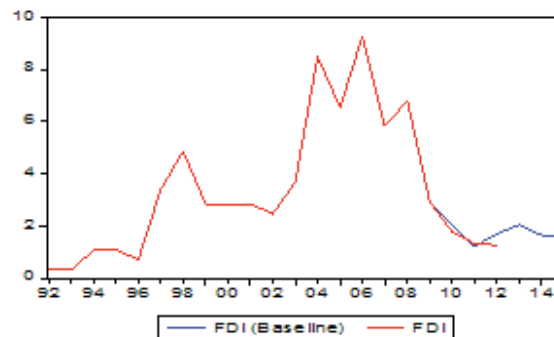
aspects consist in: no significant influences from exogenous (higher than 5% null probabilities all over), here including for dummy, despite its rule of highest coefficient respected and the lowest R-Squared in the set of five equations here considered. It seems that all belongings of active labour endogenous play pretty differently than the other variables face to current crisis.

## 8. Validity of the model – tests applied on the residuals

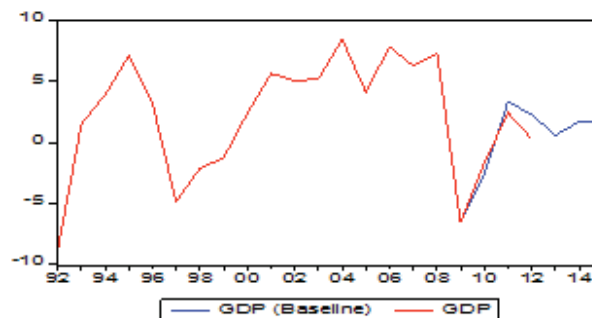
Validity of the model gets proved by tests applied on residuals. Residuals' series must be normally distributed, with no serial correlation and homoscedastic. In order to test serial correlation we applied VEC Residual Serial Correlation LM Tests with null hypothesis of  $H_0$ : no serial correlation at lag order  $h$ . Our results prove the absence of serial correlation up to lag 12. In order to test **normality** of the model we test VEC Residual Normality Tests, Orthogonalization: Cholesky (Lutkepohl) and we obtained that the series are jointly normal distributed ("p value" of Jarque Berra component is: 0,0876%) more than 5% relevance interval. The, in order to test heteroskedasticity, we applied White VEC Residual Heteroskedasticity Tests with the null hypothesis of  $H_0$ : error is homoscedastick and alternative hypotesis  $H_1$ : error are heteroscedastick . The test results proved that the series are homoscedastick with value  $p$  0,2516, which allow us to accept the null. We also tested stability of the model and all the inverse roots are inside the unit circle. A model which passes all the tests applied on the residuals, and is stable, could be used in analyses and forecasting.

Here we represent graphs for forecasted interval 2012-2015 interval.(fig 7)

a



b





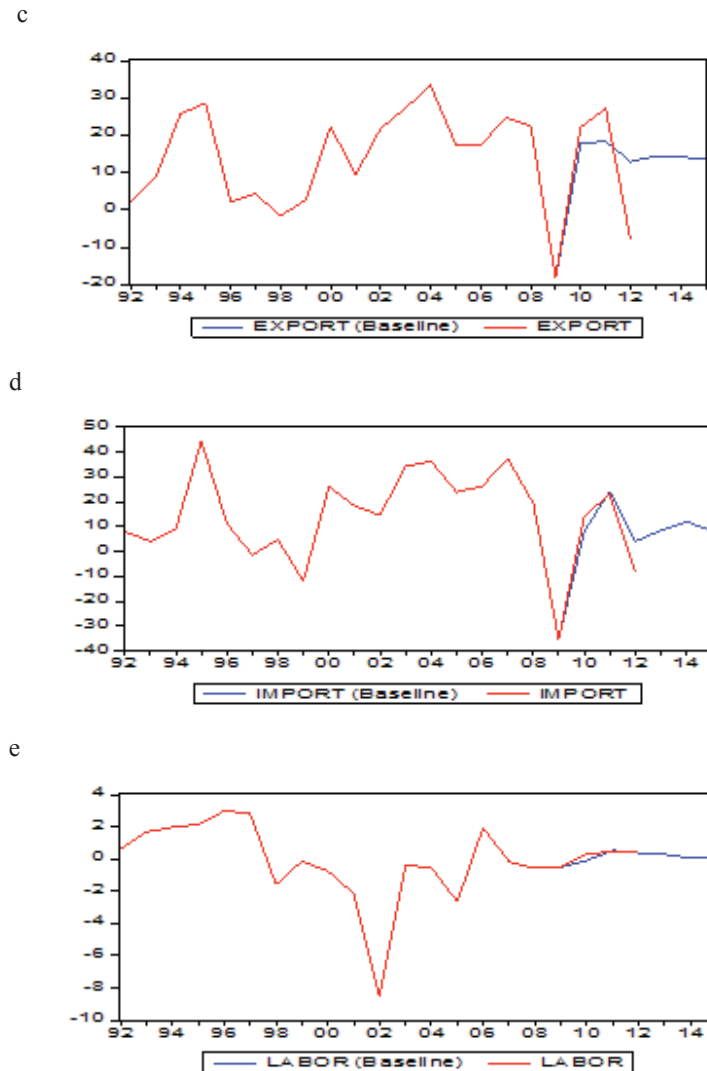


Fig. 7. Forecasted interval 2012-2015. (a) FDI,(b)GDP,(c) Export,(d) Import, (e) Labor

## Conclusions

The purpose of this paper was to econometrically analyse and examined the causal relationship among certain economic indicators in Romania by using VECM model. This study contributes to making understood cointegrating and causal relationship between foreign direct investment, economic growth, exports, imports and labour force in Romanian case. To develop this study two econometric procedures were used, which are the Johansen approach to cointegration and the procedure for Granger non-causality test. VECM was used for regression model and runned it in order to test for the presence of a long-run relationship between variables.

Overall, conclusions of our paper approach start by ‘no macroeconomic development without FDI!’ The last influence all main macro variables, including themselves. Then, there comes the rule that all FDI’s influences appear negative, i.e. on exports, imports and GDP and even on labour force, for which though context stays different than the other indicators’ ones. FDI here appears on a verge of profound future transformation of the economy, when a still inadequate economic structure, as existent. The long term horizon of such economic transforming-restructuring is foreign companies working for the home market. This includes output, exports and imports affected

for the moment, as they currently are, i.e. a rather export-oriented production apparatus with possibly small and medium size enterprises dominating the home environment.

On the contrary, FDI appear positively influenced, in the decreasing order of coefficients-influences, by other factors than the ones considered in this paper and by labour, as distinctly. The meaning of the last includes the ideas that more FDI attracting factors are to be considered, be it as specific to our country and different than other countries' around contexts. As distinctly for macroeconomic variables here considered, they might be less significant in such concern either, except for labour resource. Plus, dummy here taken shows their increased sensitivity to the crisis' influence.

We found that the economic crisis actually caused significant influence on FDI, imports, exports and GDP and rather no influence on labour, as reliable resource.

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